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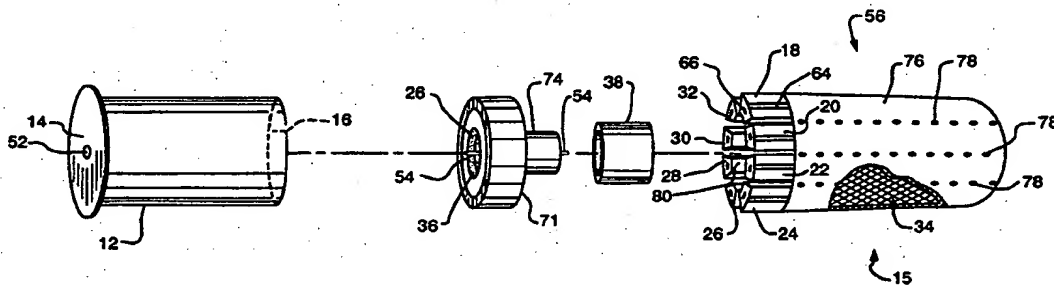
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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			(43) International Publication Date: 3 December 1998 (03.12.98)
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(71) Applicant: FOSTER-MILLER, INC. [US/US]; 350 Second Avenue, Waltham, MA 02154 (US).		Date of publication of the amended claims: 7 January 1999 (07.01.99)	
(72) Inventors: MANGOLDS, Arnis; 102 Peabody Drive, Stow, MA 01775 (US). FARINELLA, Michael, David; 27 Riverside Drive, Mansfield, MA 20248 (US). DEGUIRE, Daniel, Rene; 64 Milk Street, Blackstone, MA 01504-1105 (US). CARDENAS, Robert, Lee; 12 August Drive, Framingham, MA 01701 (US).			
(74) Agents: TESKA, Kirk et al.; Iandiorio & Teska, 260 Bear Hill Road, Waltham, MA 02154 (US).			

## (54) Title: BALLISTICALLY DEPLOYED RESTRAINING NET SYSTEM



## (57) Abstract

A ballistically deployed restraining net system including a cartridge (12) receivable within a barrel, the cartridge (12) having a base (14) and an opposing open end (16). There is a restraining net (34) packaged in the cartridge and a set of weights (18, 20, 22, 24, 26, 28, 30 and 32) attached to the restraining net (34) and packaged within the cartridge (12) between the base (14) of the cartridge and the restraining net (34). A deployment charge (36) ejects the restraining net (34) and the set of weights out of the barrel and out of the cartridge (12) and a spreader charge (38) deploys the weights after the net (34) and the set of weight exit the cartridge (12) so that the weights overtake the net (34) in flight.

20  
AMENDED CLAIMS

[received by the International Bureau on 17 November 1998 (17.11.98);  
original claims 1, 5, 23, 40 and 43 amended; remaining claims unchanged (6 pages)]

1. A non-lethal ballistically deployed restraining net system comprising:  
a cartridge, for being fired from a hand-held launcher, receivable within  
a barrel, said cartridge having a base and an opposing open end;  
5 a non-lethal restraining net packaged in the cartridge proximate the open  
end;  
a set of weights attached to said restraining net and packaged within the  
cartridge between the base of the cartridge and the restraining net;  
deployment means, positioned between said weights and said base for  
10 ejecting said restraining net and said set of weights out of the barrel and out of said  
cartridge; and  
spreader means, positioned proximate said weights, for deploying said  
weights after said net and said set of weights exit the cartridge.
2. The system of claim 1 in which said deployment means includes a  
15 deployment charge located between the base of the cartridge and the set of weights.
3. The system of claim 2 in which said cartridge includes a primer in  
communication with said deployment charge.
4. The system of claim 1 in which said spreader means includes a spreader  
charge located between said deployment means and said set of weights.
- 20 5. The system of claim 1 further including delay means, positioned between  
said deployment means and said spreader means, in communication with said deployment  
means and said spreader means for initiating said spreader means after a time delay of  
the initiation of the deployment means.
- 25 6. The system of claim 1 further including a plug receivable within the  
cartridge proximate the base portion, said plug including a cavity in one surface thereof  
for housing said deployment means.

rubber exterior.

19. The system of claim 1 in which said net includes a power source and an open electrical circuit connected to said power source for disabling a target captured in said net.

5 20. The system of claim 1 in which said net includes a disabling adhesive.

21. The system of claim 1 in which said net includes a disabling chemical.

22. The system of claim 1 in which said net includes a marking substance.

10 23. In a deployable capture system, the capture system comprising a capture device and a set of weights housed in a cartridge, the improvement comprising initially deploying said capture device and said weights from said cartridge prior to deploying said weights which overtake said capture device.

24. The system of claim 23 in which said capture device is a restraining net.

25. The system of claim 23 further including subsequently deploying the weights to overtake the capture device.

15 26. A method of ballistically deploying a restraining net system, the method comprising:

packaging a restraining net and a set of weights attached to the restraining net within a cartridge such that the weights are located between the base of the cartridge and the restraining net;

20 ejecting said restraining net and said set of weights out of a barrel and out of said cartridge; and

deploying said weights after said net and said set of weights exit the cartridge.

shape.

37. The method of claim 36 in which the step of drawing the net includes using a separator unit to maintain the proper orientation of the weights.

38. The method of claim 36 in which the step of compressing the net includes using a plunger receivable within the hollow member.

39. The method of claim 36 in which compressing the net includes removing the net from the hollow member and placing it in a press.

40. A non-lethal ballistically deployed capture system comprising:  
a cartridge receivable within a barrel, said cartridge having a base and an opposing open end;  
a non-lethal capture device comprising a restraining net or a restraining film packaged in the cartridge proximate the open end;  
a set of weights attached to said capture device and packaged within the cartridge between the base of the cartridge and the capture device;  
deployment means, positioned between said weights and said base for ejecting said capture device and said set of weights out of the barrel and out of said cartridge; and  
spreader means, positioned proximate said weights, for deploying said weights after said capture device and said set of weights exit the cartridge.

41. The system of claim 40 in which said capture device includes a restraining net.

42. The system of claim 40 in which said capture device includes a restraining film.

43. A non-lethal ballistically deployed projectile for being fired from a hand-

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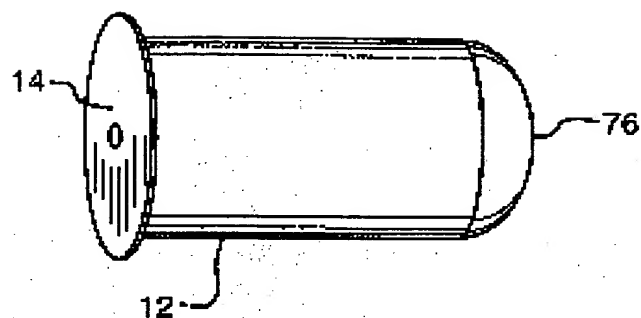


FIG. 1

FIG. 2

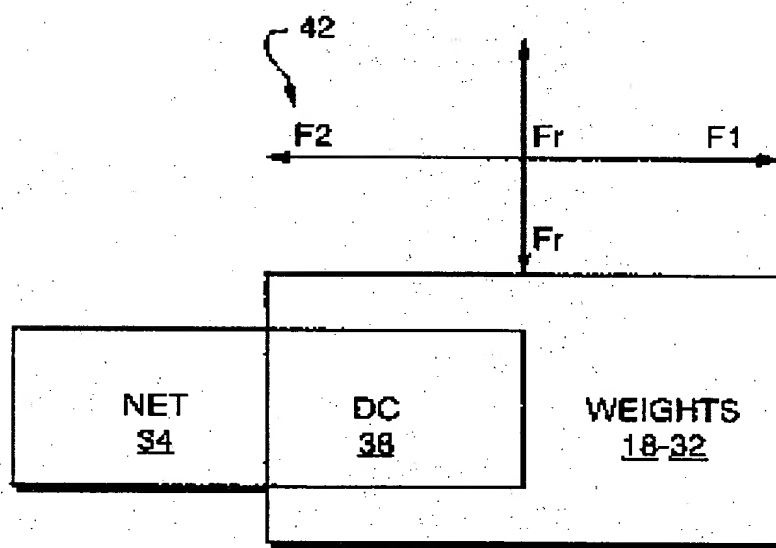
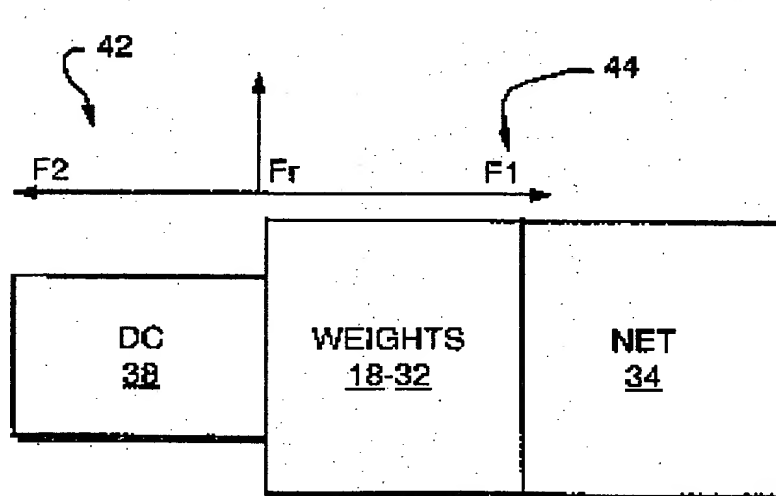


FIG. 3



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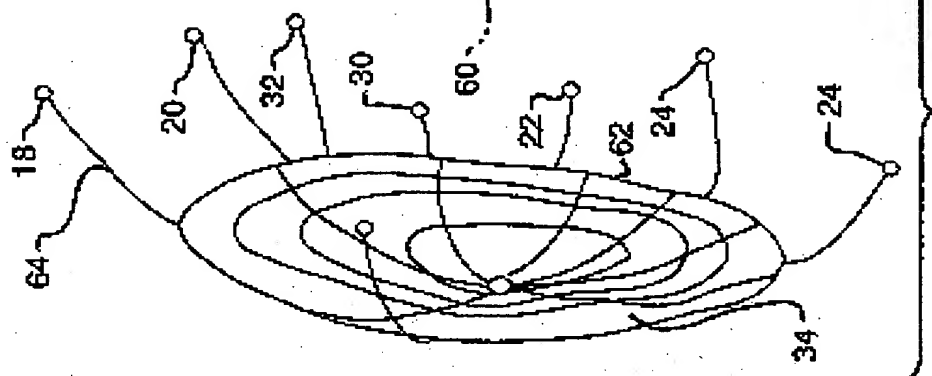


FIG. 5E

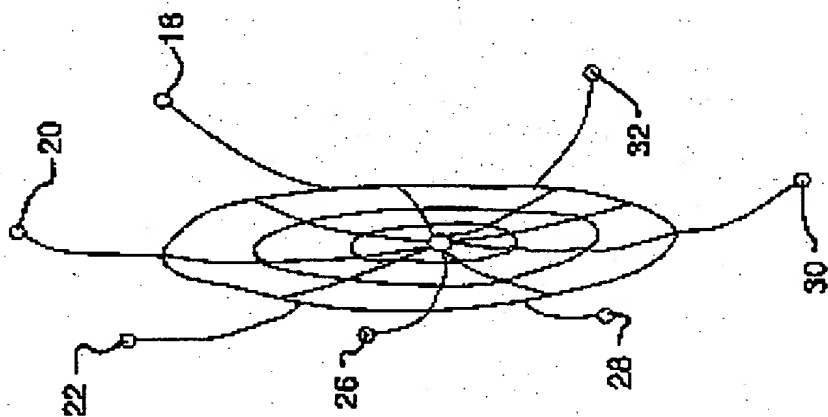


FIG. 5D

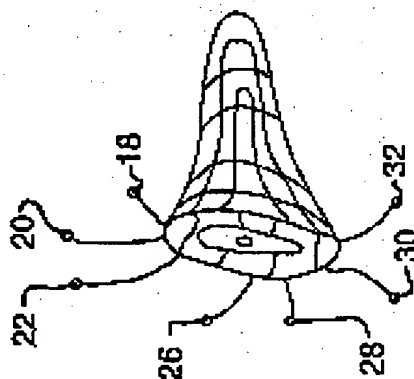


FIG. 5B



FIG. 5A

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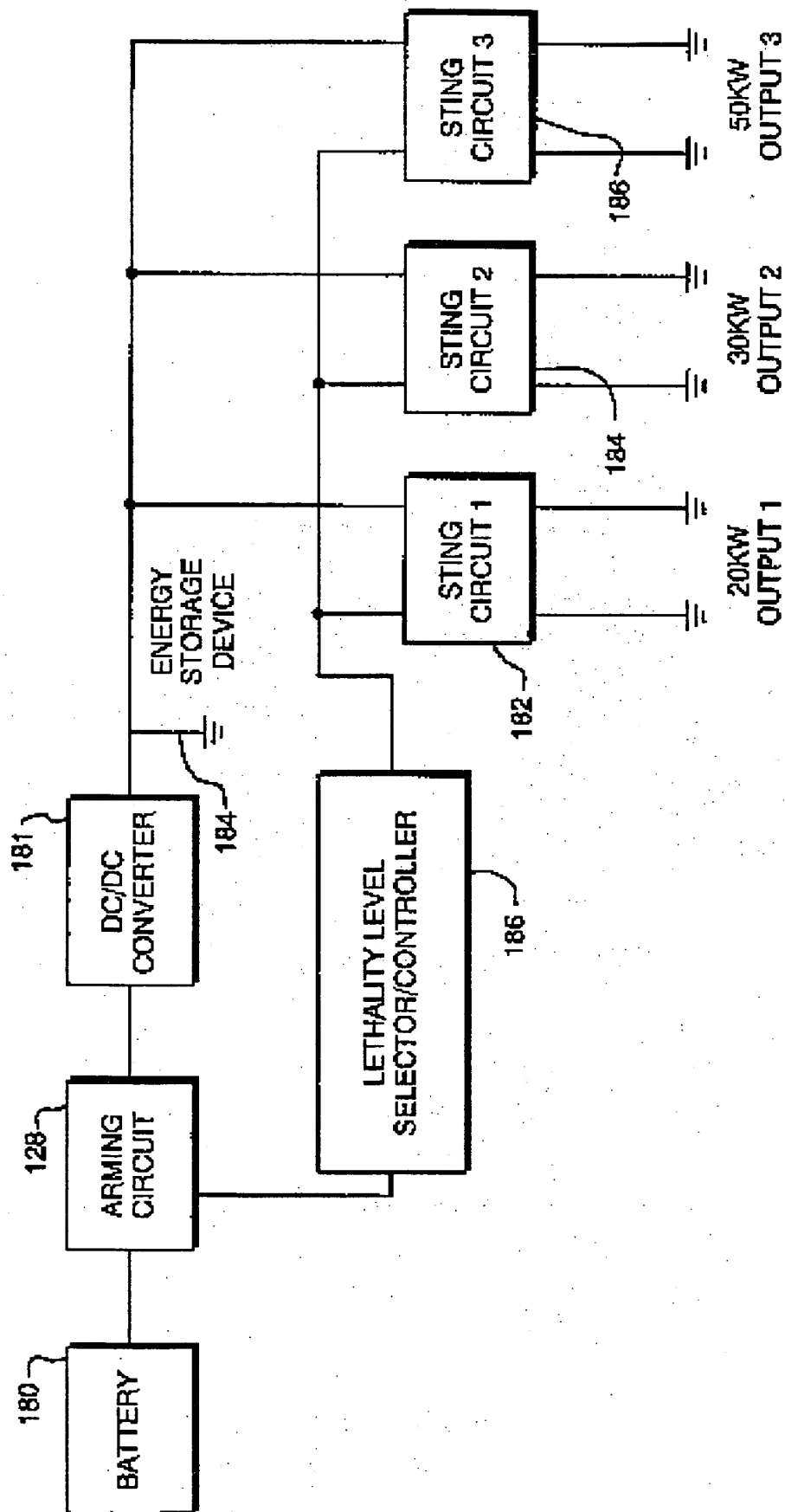


FIG. 7



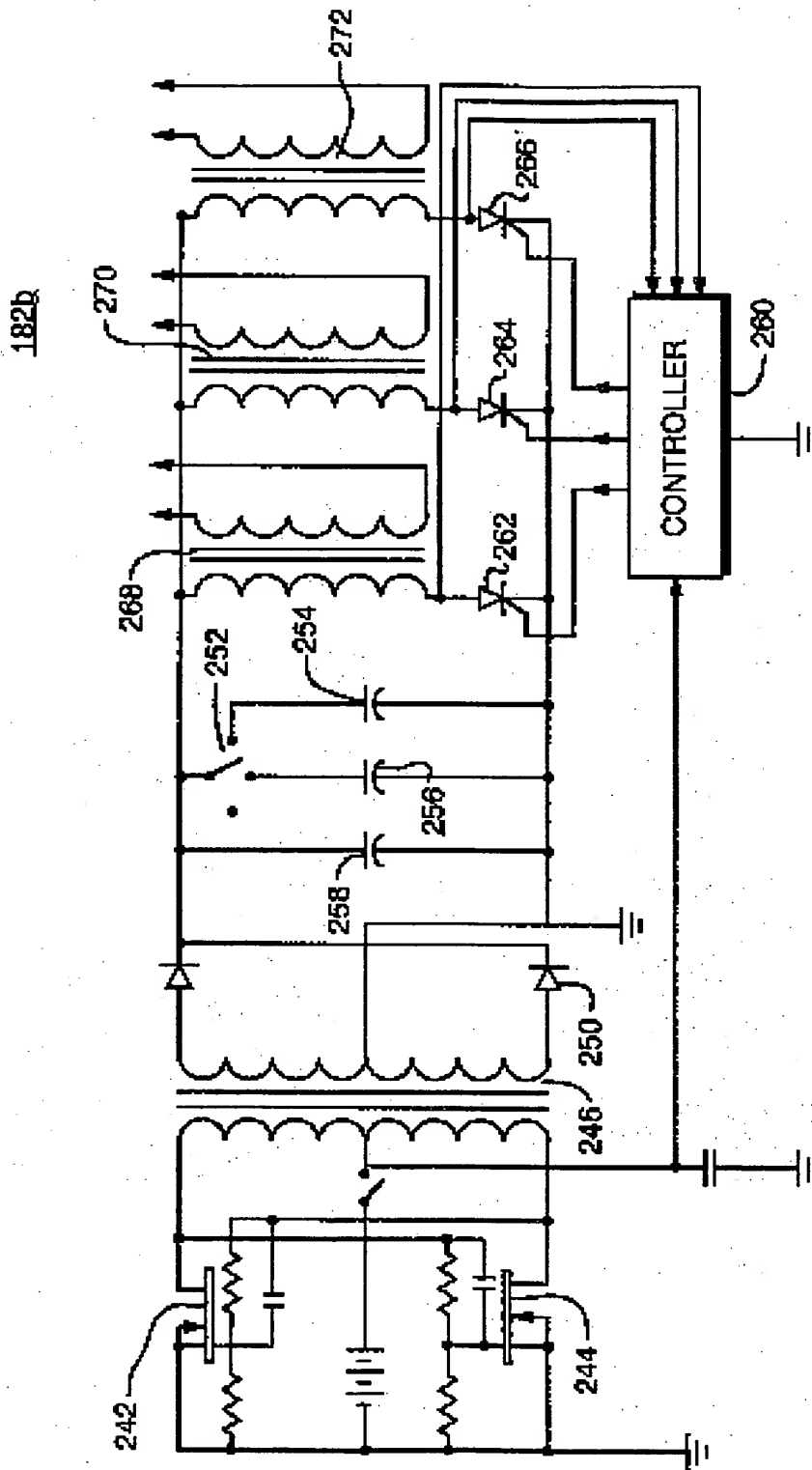


FIG. 9

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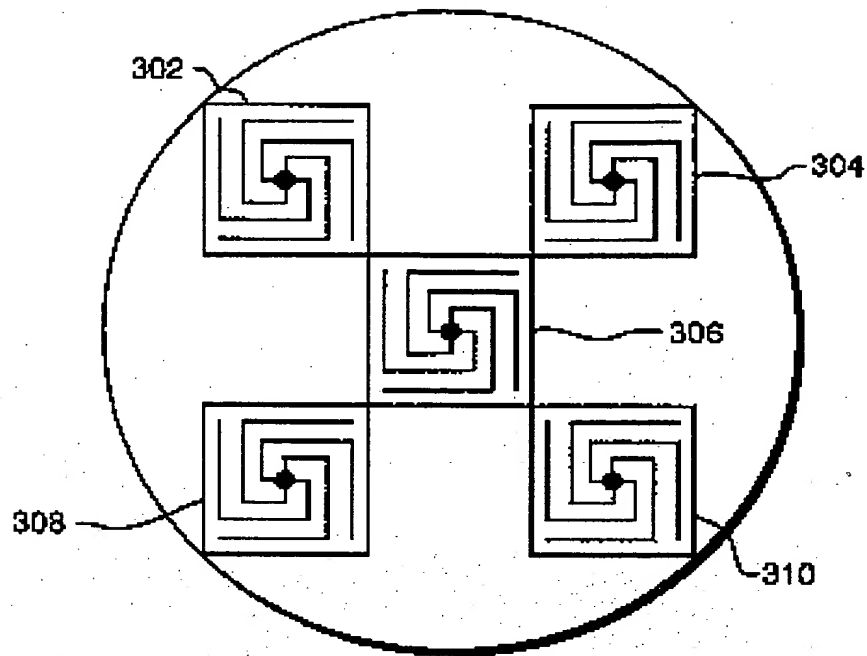


FIG. 14

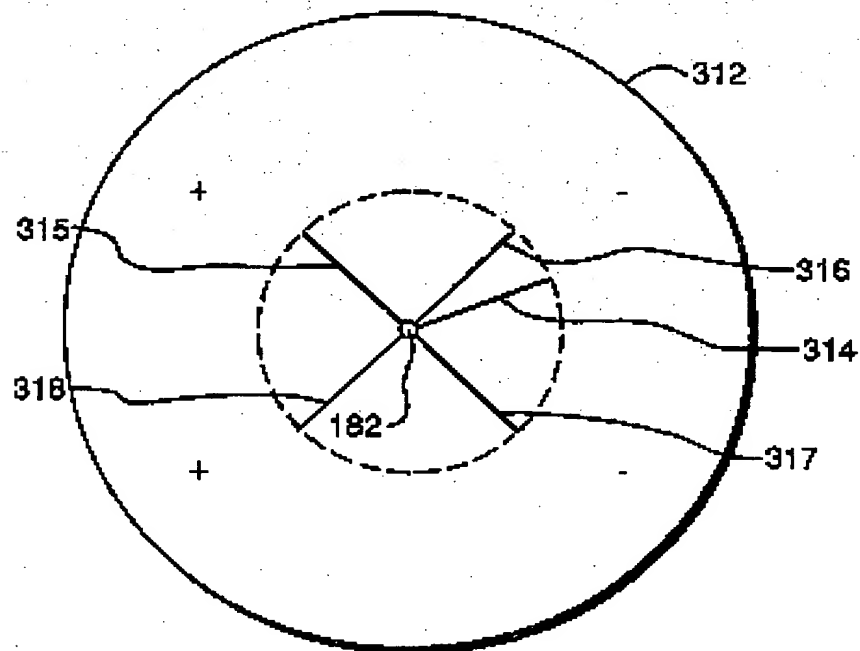


FIG. 15

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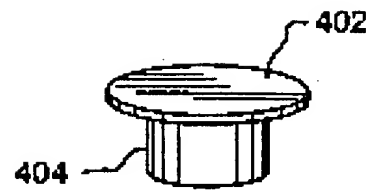


FIG. 18

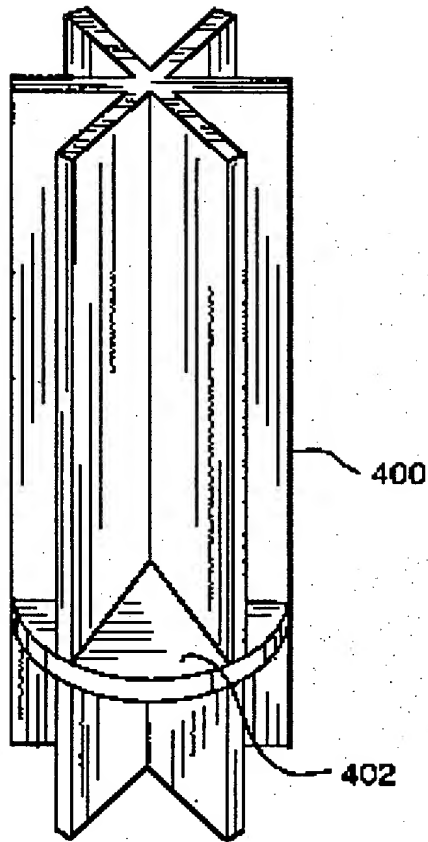


FIG. 17

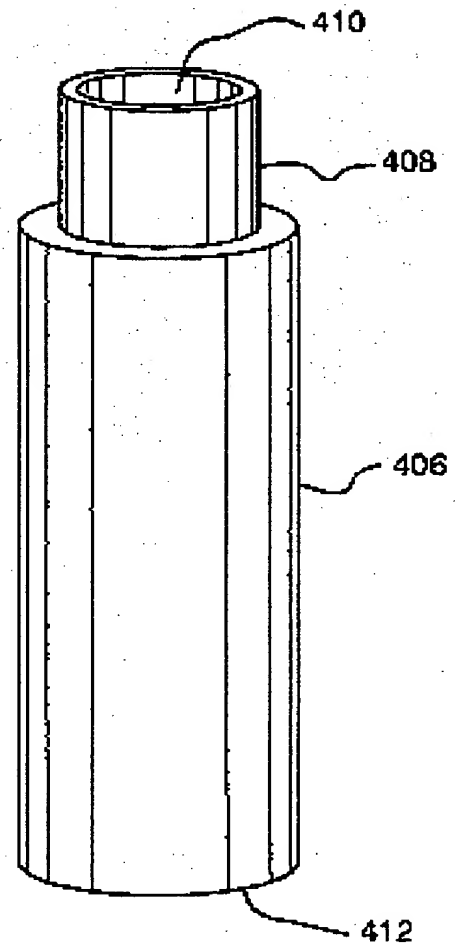


FIG. 19

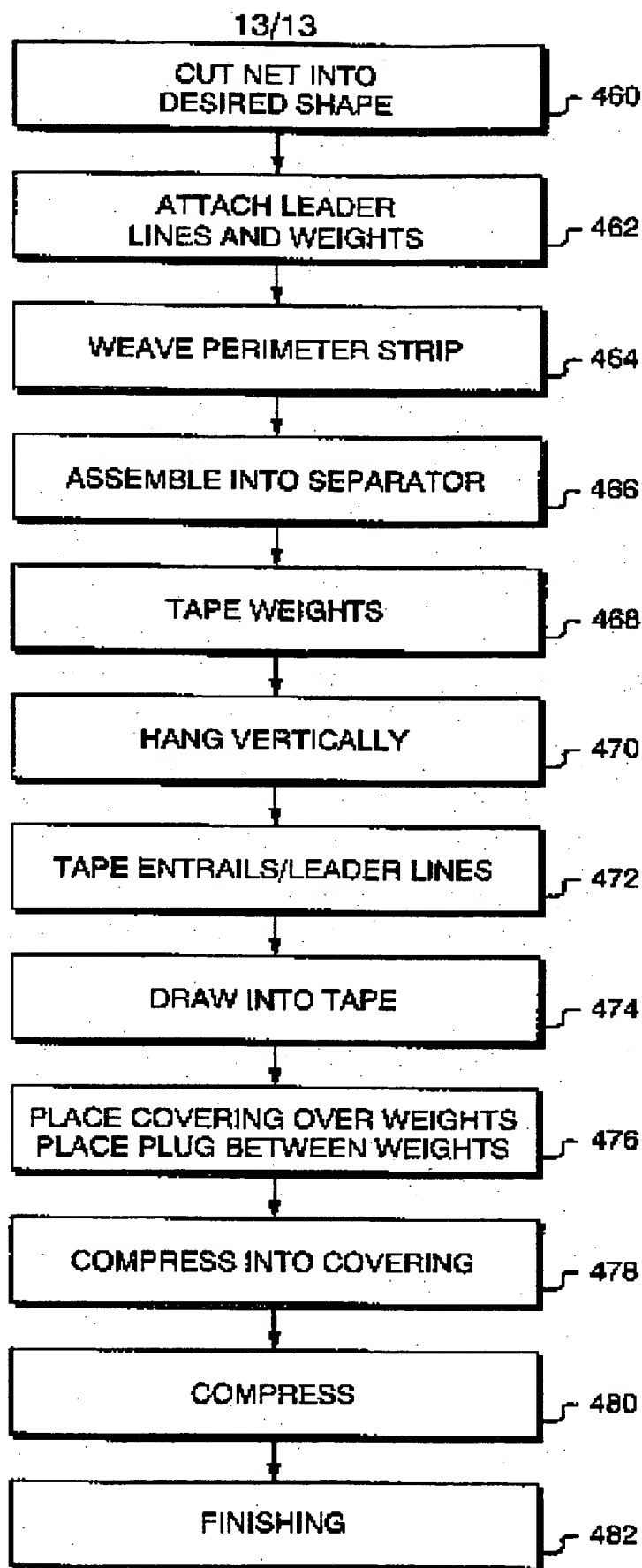


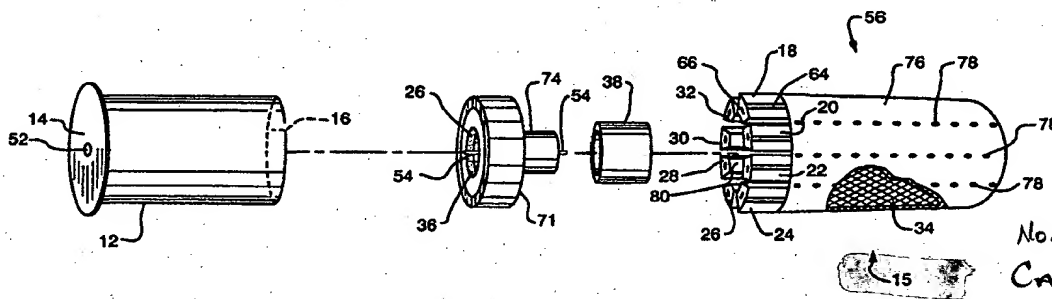
FIG. 21



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : <b>F42B 12/00</b>		<b>A1</b>	(11) International Publication Number: <b>WO 98/54538</b>
			(43) International Publication Date: 3 December 1998 (03.12.98)
(21) International Application Number: PCT/US98/09855 (22) International Filing Date: 14 May 1998 (14.05.98) (30) Priority Data: 08/866,745      30 May 1997 (30.05.97)      US (71) Applicant: FOSTER-MILLER, INC. [US/US]; 350 Second Avenue, Waltham, MA 02154 (US). (72) Inventors: MANGOLDS, Arnis; 102 Peabody Drive, Stow, MA 01775 (US). FARINELLA, Michael, David; 27 Riverside Drive, Mansfield, MA 20248 (US). DEGUIRE, Daniel, Rene; 64 Milk Street, Blackstone, MA 01504-1105 (US). CARDENAS, Robert, Lee; 12 August Drive, Framingham, MA 01701 (US). (74) Agents: TESKA, Kirk et al.; Iandiorio & Teska, 260 Bear Hill Road, Waltham, MA 02154 (US).		(81) Designated States: CA, JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.          Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	

(54) Title: BALLISTICALLY DEPLOYED RESTRAINING NET SYSTEM



## (57) Abstract

A ballistically deployed restraining net system including a cartridge (12), receivable within a barrel, the cartridge (12) having a base (14) and an opposing open end (16). There is a restraining net (34) packaged in the cartridge and a set of weights (18, 20, 22, 24, 26, 28, 30, and 32) attached to the restraining net (34) and packaged within the cartridge (12) between the base (14) of the cartridge and the restraining net (34). A deployment charge (36) ejects the restraining net (34) and the set of weights out of the barrel and out of the cartridge (12) and a spreader charge (38) deploys the weights after the net (34) and the set of weight exit the cartridge (12) so that the weights overtake the net (34) in flight.

SEE PAGE 7.

## BALLISTICALLY DEPLOYED RESTRAINING NET SYSTEM

### FIELD OF INVENTION

This invention relates to a ballistically deployed restraining net system in which a restraining net is packaged in a projectile and unfurled in flight proximate the target to be restrained.

### RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Serial No. 08/544,012 filed October 17, 1995 entitled "Ballistically Deployed Restraining Net."

### BACKGROUND OF INVENTION

There are a number of less than lethal weapons currently used by law enforcement and military personnel including tear and pepper gas sprays and bombs. These types of weapons, however, are not always effective especially when perpetrator or enemy personnel are armed. These types of weapons also sometimes fail to adequately restrain the target. Some prior restraining net systems have been developed (see, e.g., U.S. patent No. 4,912,869), but they require either specialized launching guns, have very short ranges, and/or are susceptible to entanglement on obstructions in the path between the launching gun and the target.

Law enforcement and military personnel are not usually receptive to restraining net systems which require specialized launching guns. Such systems are also cost prohibitive since the design and production costs of the launching gun are excessive. Also, restraining net systems wherein the net is deployed in its open state do not have much of a range because of the drag of the net in flight. Moreover, it is difficult to aim these types of weapons. Such systems are also easy to elude. Worse, the net in its open unfurled state can become entangled on obstructions (e.g. tree branches) in the path between the net launcher and the perpetrator. Finally, prior restraining net systems are ineffective at restraining hostile and/or armed individuals.

by attaching the weights to the interior sections of the restraining net to reduce the chance that a weight will strike an object in the path of the target.

This invention results from the further realization that a 16 foot diameter restraining net can be packaged within a 37 mm cartridge if the net is compressed both longitudinally and circumferentially within a compression jig.

This invention features a ballistically deployed restraining net system. There is a cartridge receivable within a barrel, the cartridge having a base and an opposing open end. A restraining net is packaged in the cartridge. A set of weights are attached to the restraining net and packaged within the cartridge between the base of the cartridge and the restraining net. There are deployment means (e.g. a deployment charge) for ejecting the restraining net and the set of weights out of the barrel and out of the cartridge. Finally, there are spreader means (e.g. a spreader charge) for deploying the weights after the net and the set of weights exit the cartridge. Thus, the net is ejected first and the weights then spread out and overtake the net to eliminate any forces acting on the net against its intended direction of travel. This also makes the device safer: if the spreader charge fails, the net rather than the weights will strike the target first.

The cartridge typically includes a primer in communication with the deployment charge. Further included are delay means (e.g. a delay fuse) in communication with the deployment charge and the spreader charge for initiating the spreader charge after a time delay of the initiation of the deployment charge.

In a preferred embodiment, a plug, receivable within the cartridge proximate the base portion, includes a cavity on surface thereof for housing the deployment charge. The plug includes the spreader charge on another surface thereof and an orifice therethrough in communication with both surfaces for housing the delay fuse. The one-piece plug design aids in manufacturing efficiency.

To increase the "bola" action of the weights, the weights are attached to the restraining net via leader lines. The leader lines may be attached to the perimeter of the restraining net, or in some cases, for example, indoor applications, the leader lines are attached to interior sections of the restraining net.

In a preferred embodiment, there is a housing for the restraining net and the housing includes perforations for facilitating deployment of the restraining net. The

device and the set of weights out of the barrel and out of the cartridge; and spreader means for deploying the weights after the capture device and the set of weights exit the cartridge.

#### DISCLOSURE OF PREFERRED EMBODIMENT

5 Fig. 1 is a schematic view of the restraining net system of this invention within a cartridge;

Fig. 2 is a force diagram showing the forces acting on a prior art restraining net when the perimeter weights are packaged in front of the restraining net;

10 Fig. 3 is a force diagram depicting the forces acting on the restraining net system of this invention wherein the perimeter weights are packaged in back of the restraining net;

Fig. 4 is an exploded schematic view of the ballistically deployed restraining net system show in Fig. 1;

15 Figs 5A-5E are schematic views showing the deployment of the restraining net system according to this invention;

Fig. 6 is a schematic view showing another embodiment of the restraining net system of this invention wherein the perimeter weights are tied to the interior sections of the net to reduce the chance that the weights will strike an object in the path of the target;

20 Fig. 7 is a block diagram of a sting net circuit component for the restraining net system of this invention;

Fig. 8 is a circuit diagram of one embodiment of the sting circuit shown in Fig. 7;

25 Fig. 9 is a circuit diagram of another embodiment of the sting circuit shown in Fig. 7;

Figs. 10 - 15 are schematic views of the various net wiring configurations for the sting circuits shown in Figs. 8 and 9;

Fig. 16 is a top view of the initial net packaging layout in accordance with this invention;

30 Fig. 17 is a schematic view a separator unit used to package the restraining net of this invention within a cartridge;



5 In operation, the hammer of gun 50, Fig. 5A, strikes primer 52, Fig. 4, of cartridge 12 which in turn ignites deployment charge 36 and delay fuse 54. The explosion of deployment charge 36 ejects the combination of weight and net package 56, Fig. 4, and approximately 20 to 30 milliseconds thereafter, as shown in Fig. 5B, delay fuse 54, Fig. 4, ignites spreader charge 38 which spreads out weights 18-32 as shown in Fig. 5C. As shown in Fig. 5D, weights 18-32 are now fully deployed and as shown in Fig. 5E, net 34 is fully deployed as weights 18-32 accelerate ahead of net 34. Full deployment of net 34 occurs within about 5 feet of gun 50, Fig. 5A. The effective capture zone for capturing perpetrator 60 is approximately 25 additional feet after full deployment at 5 feet. This increased range is an improvement over prior devices wherein the weights are always packaged in front of the capture net. And, as explained above, should spreader charge 38, Fig. 4 fail to fire, net 34 will strike perpetrator 60, Fig. 5E first rather than weight set 18-32.

10 Another significant advantage of the subject invention is that weights 18-32 are not attached directly to the perimeter 62, Fig. 5E of net 34 but instead are attached via 3 foot long leader lines 64 as shown for weight 18. These leader lines act in a "bola" like fashion to improve the effectiveness of the restraining net system. In the embodiment shown in Fig. 5E, the leader lines are attached to the perimeter 62 of ten foot diameter net 34. Weights 18-32, Fig. 4, are made of lead, rubber such as "Ultra High Mass" rubber available from the Griffiths Rubber Co. 2625 NW Industrial Portland, Oregon 97210, are fabricated of a lead core covered in rubber or are made up of bean bag type structures. Each lead weight, as shown for weight 18, has a hole through it as shown at 66 for attaching leader line 64 to the perimeter weight. In the preferred embodiment, the net is cut into an octagon shape and there are 16 weights, one attached to each corner of the octagon shaped net on one inch leader lines and one disposed between the corners on two foot leader lines. The short leader line weights function to deploy the net and the long leader line weights function to assist in the capture of the perpetrator via a bola type action.

25 In the preferred embodiment, plastic plug 70 houses both deployment charge 36 and spreader charge 38. Plug 70 is receivable within cartridge 12 proximate base portion 14 thereof. Plug 70 includes cavity 72 for housing deployment charge 36. Spreader

The weights can be fabricated from any material which will provide the mass to—  
fully deploy the net, provide forward momentum for sustained flight and enough  
momentum to swing the net around the target and become entangled.

5 The net can be incorporated with one or more "sting" circuits to shock and  
disable a perpetrator. A power source 180, Fig. 7, such as a 6-volt battery, supplies  
current to sting circuits 182, 184, and 186 to provide open 50 kv electrical circuits  
integral within net 34, Fig. 5E. DC/DC voltage converter generator 181 with a step-up  
transformer and full wave bridge rectifier converts the battery voltage and charges energy  
0 storage capacitor 184 to an intermediate voltage of 500 to 1000V. Microcontroller 186  
provides the ability to sequentially activate several electronic switches to channel the  
energy in storage capacitor 184 through a step-up transformer to wiring in the net.  
Several independent output circuits 182, 184, 186 each driven by one of the electric  
switches provide redundancy in case one or more of the circuits in the net is shorted or  
broken.

5 Arming circuit 128 activates the sting circuit only after the net has been unfurled.  
Primary power is provided to first stage dc/dc converter 181 that produces an  
intermediate voltage of about 1000VDC and powers the individual sting circuits 182,  
184, and 186. Power is also sent to the lethality level selector and controller 186.  
Circuit 186 controls the pulse rate and voltage level of the individual sting circuits.  
10 Capacitor 184 maintains energy storage in the intermediate voltage supply system. Sting  
circuits 182, 184, and 186 step the final voltage level up to 2kV to 100kV, depending  
on the level selected. Should one of the HVP outputs become shorted, the other circuits  
will continue to operate independently.

15 The operation of the non-tunable circuit 182a, Fig. 8, is as follows. During  
deployment, on/off switch 200 is automatically closed by arming circuit 128, Fig. 7 and  
power from battery 201 is applied to the circuit. Transistor 202, Fig. 8, together with  
transformer 206 form a self-oscillating DC-DC converter. The output of the converter  
is a transformer which produces a 400V AC signal across the diode 208. The output  
diode 208 is a half wave rectifier that converts the waveform back to a DC waveform  
30 of 200V peak. As the electrical voltage rises across SCR 222, neon gas source 220  
ionizes causing SCR 222 to turn on thereby discharging the voltage across transformer

in elastomer package 314 at the apex of net 312. Leads 315, 316, 317 and 318 extend as shown.

5 In another embodiment, a capture film is used as the capture medium rather than a net. Alternatively, films may be incorporated into a net for the purposes of aiding deployment, sustaining opened flight, and for the purpose of reducing the visibility of the target, thereby adding to confusion and enhancing entanglement and increasing escape times.

10 The film is constructed of light weight, thin ( $<.001$  in.) polymer materials, optionally coated with reflective aluminum powder. The film is attached in layers on the leading edge in a series of concentric rings forming air passage which minimize aerodynamic drag. The films are also independent of the mesh therefore acting as a secondary barrier against escape. This independent construction where the film is on the outside prevents self entanglement of the law enforcement officer.

15 Any number of markers foams, gaseous, liquid or power based markets, irritants or incapacitants can be incorporated into the net such as chloroacetophenone (CN), orthochlorobenzal-malononitrile (CS), oleoresin capsicum (OC), or their blends. Also a variety of UV or visual markers and dyes can be used. Sticky foam or other structural adhesives can be applied and in application, the net is encased in a polymer sock and sealed around the spreader gun. The net is stored in the adhesive. During deployment, 20 the spreader gun ruptures the sock and spreads the net which is coated with the adhesive, irritant, or marker. High vapor pressures in the hermetically sealed sock maintain the viscous nature of the net coatings such that shelf life is greatly enhanced. In those embodiments which require vaporization the large surface area of the net and rapid expansion volatizes the carrier compounds. The direct contact with the target 25 concentrates the effect and therefore permits minimal use of the irritants, and limits unwanted migration and collateral damage.

30 Projectile 56, Fig. 4, is packaged in accordance with the methodology depicted via the flow chart shown in Fig. 21. The bulk net material is first cut into the desired shape, step 460. The weights are then attached to the leader lines of the net as shown in Fig. 16. Eight weights, as shown for weight 26, are attached to each corner of the octagon shaped net via one inch leader lines and eight additional weights are attached to

5 other half 422 of the compression jig is then coupled to lower half 424 and end plug cover 430 is secured to this assembly to maintain the position of end plug 428 during compression. Jig 420 is then placed in a press such as a Enerpack Press from Applied Power Industry and a pressure rod (not shown) is placed against spacer disk 426 and subjected to a pressure of about 8 psi for five minutes, step 480, Fig. 21.

10 The pressure is then released, end cap 426 is removed, along with the duct tape securing it and a heat gun is used to heat shrink the ends of the plastic sleeve about the weight package. The spacer plug is then removed, a paper wafer is inserted in the plastic sleeve abutting the net, and the heat gun is then used to heat shrink the plastic sleeve about the paper wafer and the nets.

15 Finally, a smaller Kapton disk is pressed in between the weights to protect them and their leader lines from heat caused by spreader charge 38, Fig. 4. The plastic sleeve is trimmed as necessary, and the projectile is now ready for insertion along with spreader charge 38 and plastic plug 70 into cartridge 12, Fig. 4, step 482, Fig. 21.

Although specific features of this invention are shown in some drawings and not others, this is for convenience only as each feature may be combined with any or all of the other features in accordance with the invention.

Other embodiments will occur to those skilled in the art and are within the following claims:

20 What is claimed is:

8. The system of claim 7 in which said plug includes an orifice therethrough in communication with both said surfaces.

9. The system of claim 8 further including delay means within said orifice in communication on one end thereof with said spreader means and on the other end thereof said deployment means.

10. The system of claim 9 in which said delay means includes a fuse.

11. The system of claim 1 in which said weights are attached to said restraining net via leader lines.

12. The system of claim 11 in which said leader lines are attached to the perimeter of said restraining net.

13. The system of claim 11 in which said leader lines are attached to interior sections of said restraining net.

14. The system of claim 1 further including a housing for said restraining net.

15. The system of claim 14 in which said housing includes perforations for facilitating deployment of said restraining net.

16. The system of claim 1 in which said weights are rubber.

17. The system of claim 1 in which said weights are lead.

18. The system of claim 1 in which said weights are metallic surrounded by rubber exterior.

19. The system of claim 1 in which said net includes a power source and an

28. The method of claim 27 in which said cartridge includes a primer in communication with said deployment charge.

29. The method of claim 27 in which deploying includes placing a spreader charge between the deployment charge and the set of weights.

5 30. The method of claim 23 further including deploying the weights after the ejection.

31. The method of claim 26 in which said weights are attached to said restraining net via leader lines.

10 32. The method of claim 31 in which said leader lines are attached to the perimeter of said restraining net.

33. The method of claim 31 in which said leader lines are attached to an interior section of said restraining net.

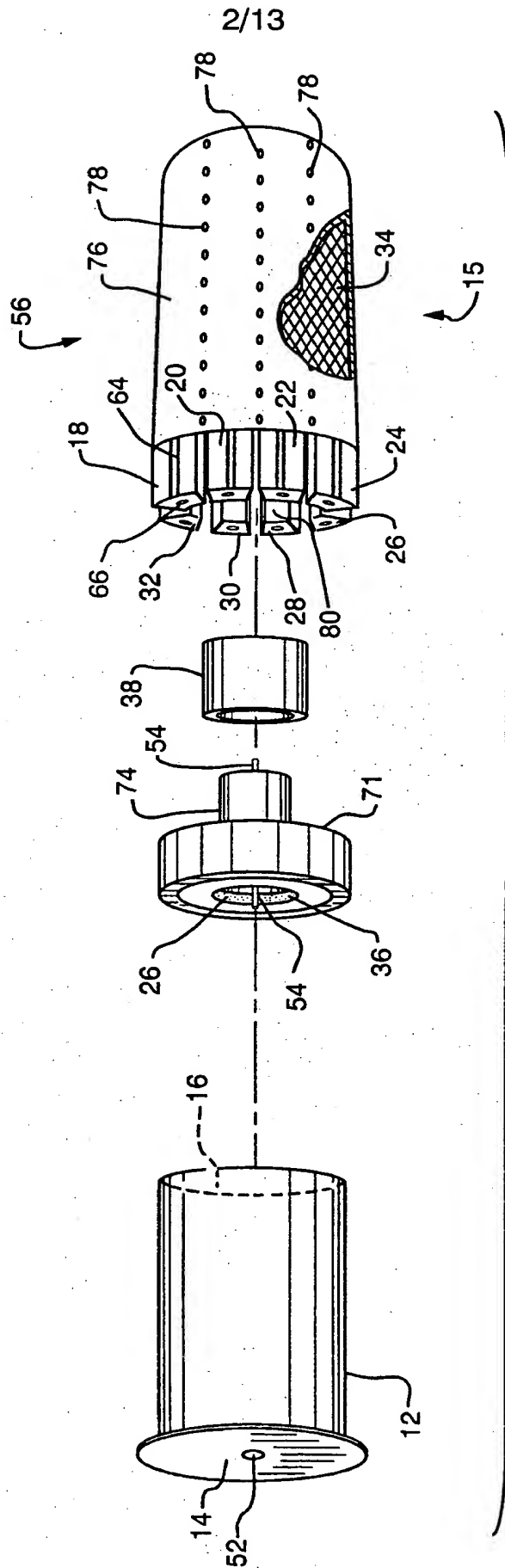
34. The method of claim 26 further including disposing a housing about said restraining net receivable within the cartridge.

15 35. The method of claim 34 further including perforating the housing to facilitate deployment of said restraining net.

20 36. A method of packaging a restraining net, the method comprising:  
attaching weights to the restraining net;  
drawing the net longitudinally within a lengthy hollow member; and  
compressing the net longitudinally and circumferentially into a bullet shape.

37. The method of claim 36 in which the step of drawing the net includes

means for ejecting said projectile out of a barrel forward portion first; and  
means for deploying said weights after the net and the weights exit the  
barrel.





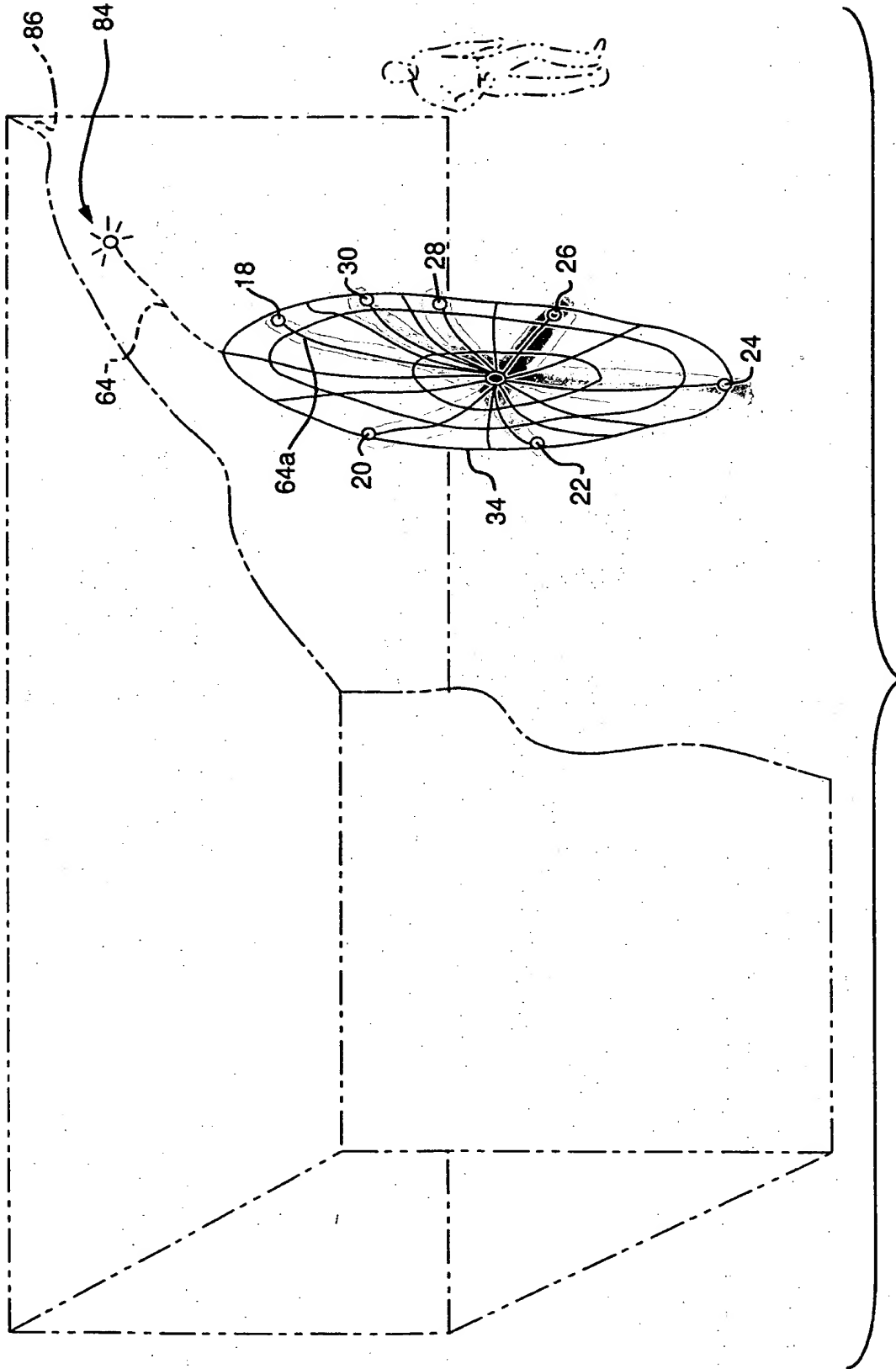


FIG. 6

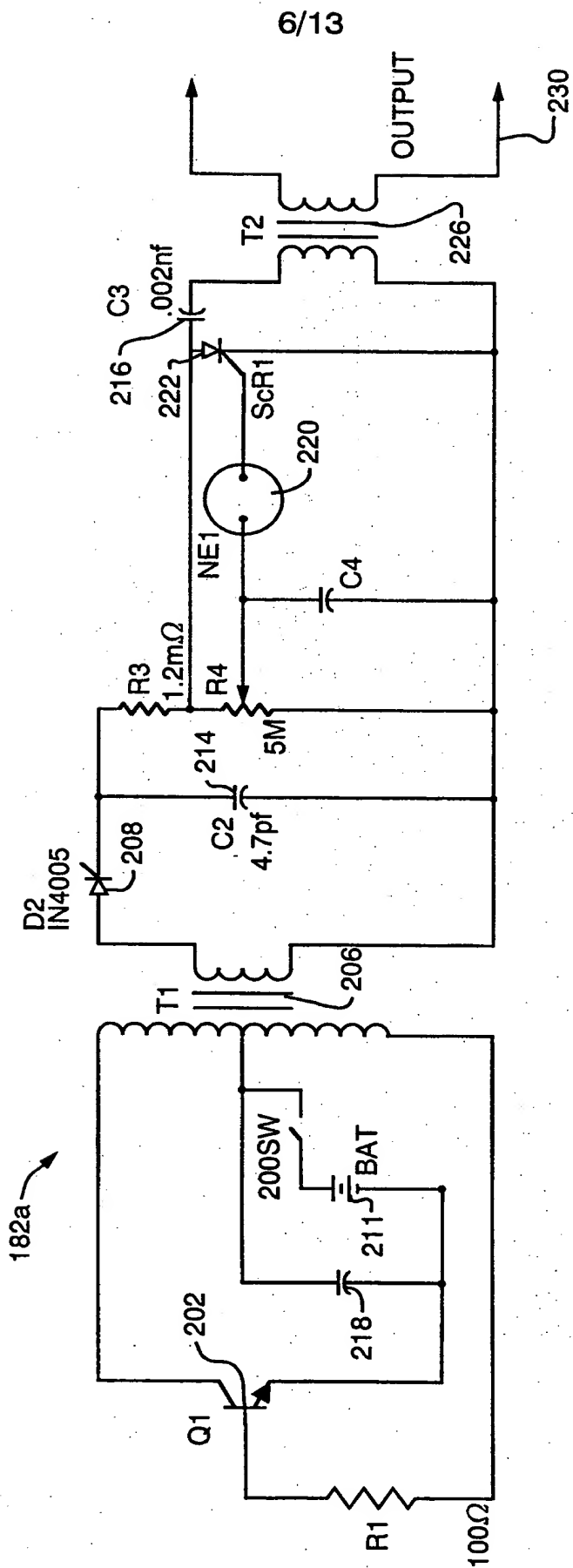


FIG. 8

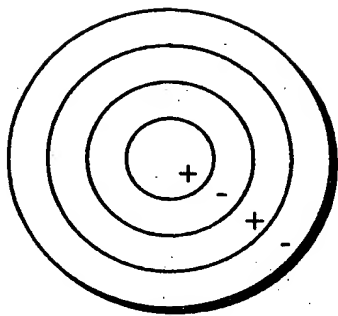


FIG. 10

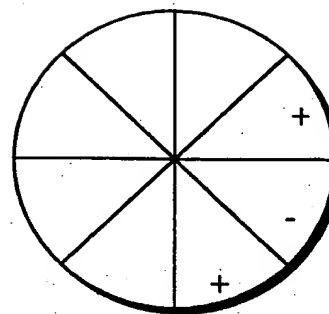


FIG. 11

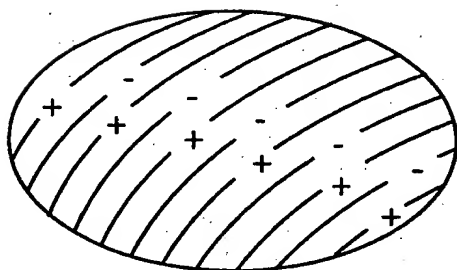


FIG. 12

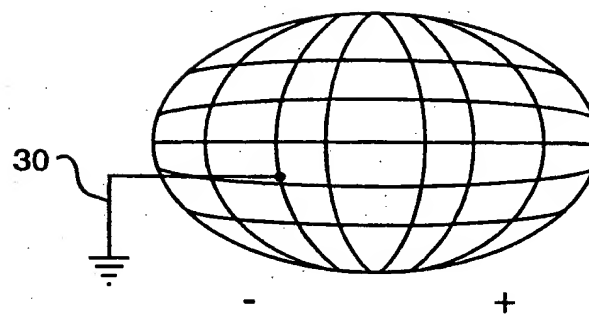


FIG. 13

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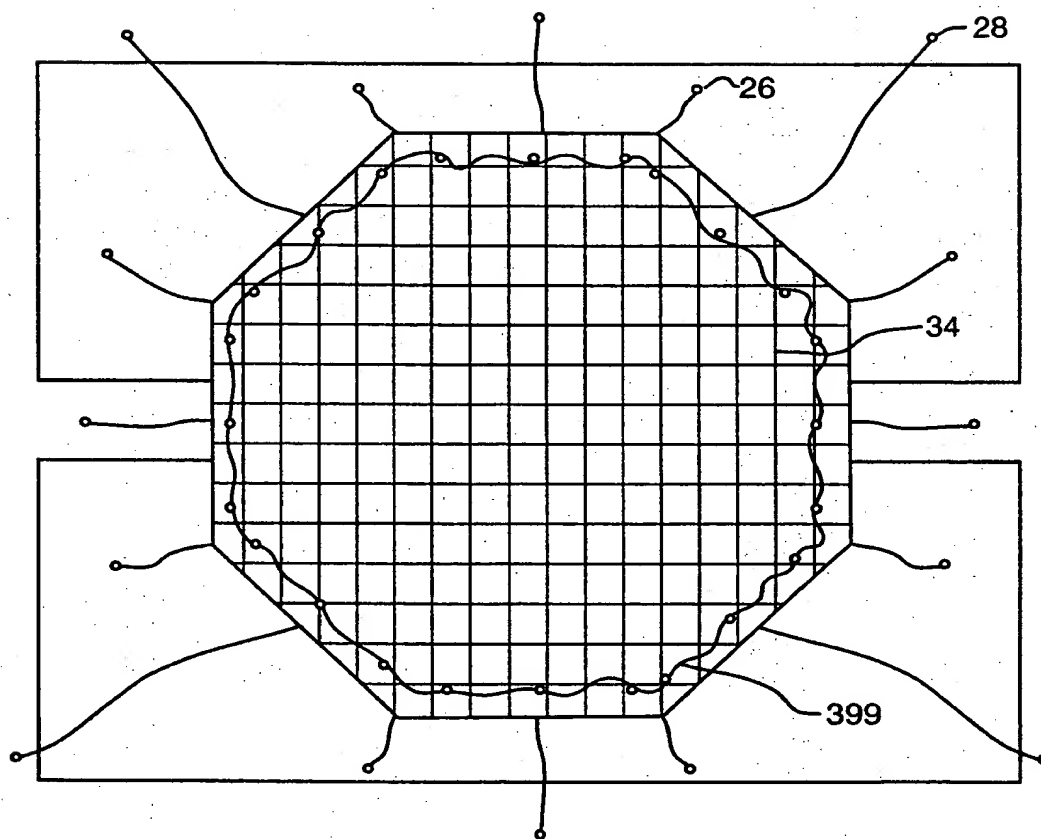


FIG. 16

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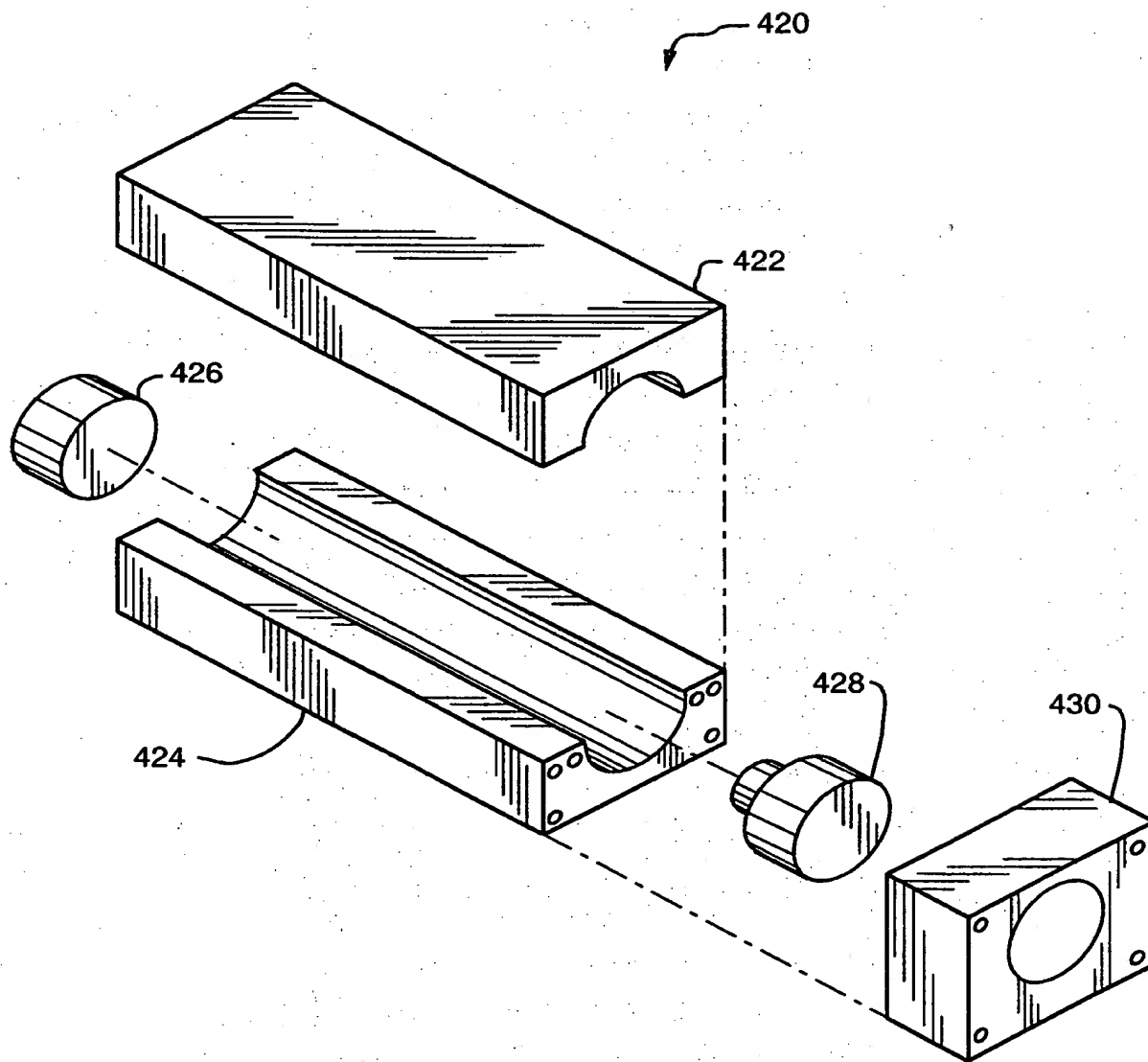


FIG. 20

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/09855

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : Please See Extra Sheet.

US CL : 102/502

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 102/293, 430, 434, 438, 439, 44, 447, 502, 504, 506, 529, 532;  
86/11.1; 89/1.11, 1.34; 29/ 1.2; 361/232; 43/96

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, (projectile # or bullet) and net #

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 1,309,530 A (LAMBERSON) 08 July 1919 (08/07/19), see entire document.	23, 25 -- 40
X -- Y	US 3,710,720 A (MAWHINNEY) 16 January 1973 (16/01/73), see Figure 6 and lines 17-24 of col. 3.	36 -- 38
X -- Y	US 4,768,417 A (WRIGHT) 06 September 1988 (06/09/88), see Figures 3 and 4, line 45 of col. 3 line 34 of col. 4.	36 -- 38
X -- Y	US 2,251,918 A (DAWSON) 12 August 1941 (12/08/41), see entire document.	23-25, 30 ----- 1-4,6,11-22 26- 29, 31-35, 40-43

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*A* document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means	
*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

10 SEPTEMBER 1998

Date of mailing of the international search report

29 OCT 1998

Name and mailing address of the ISA/US  
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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/09855

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

- Group I, Figures 5D and 5E, claims 1-12, 14-32, 34-41 and 43.
- Group II, Figure 6, claims 1-11, 13-31, 33-41 and 43.
- Group III, A restraining film (not illustrated), claims 23, 25, 30, 40 and 42.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.